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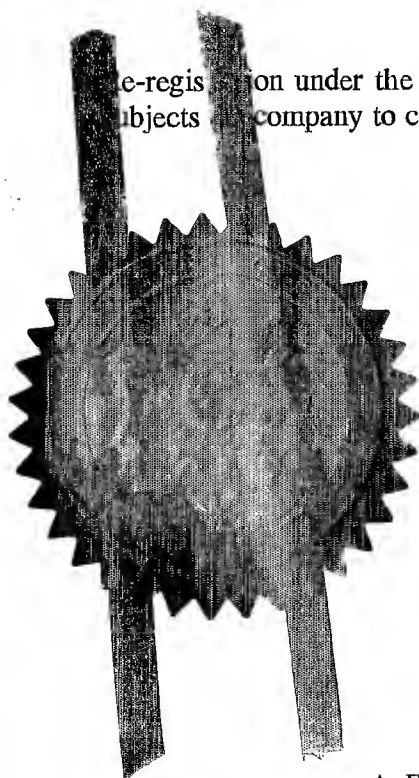
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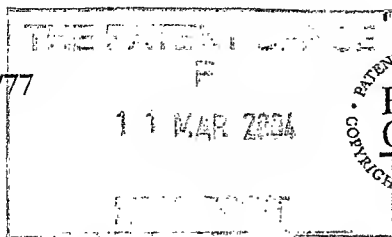
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## Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1. Your reference	P36765-/NGR/DBR/GMU		
2. Patent application number (The Patent Office will fill this part in)	0405454.0		11 MAR 2004
3. Full name, address and postcode of the or of each applicant (underline all surnames)	DES Enhanced Recovery Limited Westhill Business Centre Arnhall Business Park Westhill Aberdeen AB32 6US 8642258001		
Patents ADP number (if you know it)			
If the applicant is a corporate body, give the country/state of its incorporation			
4. Title of the invention	"Apparatus and Method for Recovering Fluids from a Well"		
5. Name of your agent (if you have one)	Murgitroyd & Company		
"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)	165-169 Scotland Street Glasgow G5 8PL		
Patents ADP number (if you know it)	1198015 ✓		
6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.	Country	Priority application number (if you know it)	Date of filing (day / month / year)
7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute (see note d)	Number of earlier UK application	Date of filing (day / month / year)	
8. Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request?	Yes		
Answer YES if:			
a) any applicant named in part 3 is not an inventor, or			
b) there is an inventor who is not named as an applicant, or			
c) any named applicant is a corporate body.			
Otherwise answer NO (See note d)			

## Patents Form 1/77

9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form

Description	27
Claim(s)	-
Abstract	-
Drawing(s)	7 17 8

10. If you are also filing any of the following, state how many against each item.

Priority documents	-
Translations of priority documents	-
Statement of inventorship and right to grant of a patent (Patents Form 7/77)	-
Request for a preliminary examination and search (Patents Form 9/77)	-
Request for a substantive examination (Patents Form 10/77)	-
Any other documents (please specify)	-

11. I/We request the grant of a patent on the basis of this application.

Signature(s)

*Debi Brown*

Date 10 March 2004

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom

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1    Apparatus and Method for recovering fluids from a  
2    well

3  
4    The present invention relates to a method and  
5    apparatus for recovering fluids from a well and  
6    injecting fluids into the well. The invention  
7    relates especially, but not exclusively, to  
8    simultaneous recovery and injection.

9  
10   A flow diverter assembly for use in a well tree is  
11   known from our PCT Application No WO 00/70185. This  
12   discloses a flow diverter assembly which is located  
13   within the production bore of a tree. However, this  
14   means that the tree cap must first be removed before  
15   the flow diverter assembly is installed. Removing  
16   and repositioning the tree cap risks damage to the  
17   cap and requires costly preparation, as a secure  
18   tree cap is vital to control the pressure in the  
19   well, and if the tree cap were to be incorrectly  
20   replaced, a blow-out could occur.

21

1 Produced fluids from an oil well typically comprise  
2 a mixture of hydrocarbons, water and sand. At  
3 present, when production fluids are recovered, they  
4 are taken to the surface (e.g. a rig or even to  
5 land) before the hydrocarbons are separated from the  
6 unwanted sand and water. Conveying the sand and  
7 water such great distances is wasteful of energy.  
8 Furthermore, fluids to be injected into a well are  
9 often conveyed over significant distances, which is  
10 also a waste of energy.

11  
12 According to a first aspect of the present invention  
13 there is provided a flow diverter assembly for a  
14 christmas tree, the flow diverter assembly  
15 comprising:

16 a flow diverter means to divert fluids from a  
17 first portion of a first flowpath to a second  
18 flowpath, and to divert fluids from the second  
19 flowpath back to a second portion of the first  
20 flowpath, the first portion of the first flowpath,  
21 the second flowpath and the second portion of the  
22 first flowpath forming a conduit for continuous  
23 passage of fluid;

24 wherein the flow diverter assembly is adapted  
25 to connect to a branch of the christmas tree.

26  
27 The flow diverter assembly being adapted to connect  
28 to a branch of the tree means that the tree cap does  
29 not have to be removed to fit the flow diverter  
30 assembly. Embodiments of the invention can be  
31 easily retro-fitted to existing trees.

32

1 Typically, at least a part of the flow diverter  
2 assembly is adapted to be inserted within a choke  
3 body. Alternatively, the flow diverter assembly  
4 could be located in a branch of the tree (or a  
5 branch extension) in series with a choke. For  
6 example, the flow diverter assembly could be located  
7 between the choke and the production wing valve or  
8 between the choke and the branch outlet. Further  
9 alternative embodiments could have the diverter  
10 assembly located in pipework coupled to the tree,  
11 instead of within the tree itself. Such embodiments  
12 allow the flow diverter assembly to be used in  
13 addition to a choke, instead of replacing the choke.

14  
15 Preferably, the flow diverter assembly is located  
16 within a bore in the branch of the christmas tree.  
17 Preferably, the flow diverter assembly comprises a  
18 conduit. Preferably, the conduit is adapted to be  
19 sealed within the branch bore. Preferably, the  
20 conduit divides the branch bore into two separate  
21 regions, so that the first portion of the first  
22 flowpath and the second portion of the first  
23 flowpath comprise the outside and the inside of the  
24 conduit respectively.

25  
26 Typically, the flow diverter assembly has an outer  
27 cylindrical member. Preferably, one of the portions  
28 of the first flowpath comprises an annulus between  
29 the outer cylindrical member and the conduit.  
30 Preferably, one of the portions of the first  
31 flowpath comprises an interior bore of the conduit.

32

1 Typically, the second flow path comprises at least  
2 one conduit. Preferably, the second flow path  
3 comprises two conduits which lead to and from a  
4 processing apparatus.

5  
6 Typically, the processing apparatus is selected from  
7 at least one of the group consisting of:  
8 a pump; a process fluid turbine; injection apparatus  
9 for injecting gas or steam; chemical injection  
10 apparatus; a fluid riser; measurement apparatus;  
11 temperature measurement apparatus; flow rate  
12 measurement apparatus; constitution measurement  
13 apparatus; consistency measurement apparatus; gas  
14 separation apparatus; water separation apparatus;  
15 solids separation apparatus; and hydrocarbon  
16 separation apparatus.

17  
18 According to a second aspect of the present  
19 invention there is provided a tree having:

20 a flow diverter assembly comprising a flow  
21 diverter means to divert fluids from a first portion  
22 of a first flowpath to a second flowpath, and to  
23 divert fluids from the second flowpath back to a  
24 second portion of the first flowpath, the first  
25 portion of the first flowpath, the second flowpath  
26 and the second portion of the first flowpath forming  
27 a conduit for continuous passage of fluid;

28 wherein the flow diverter assembly is connected  
29 to a branch of the christmas tree.

30

31 Typically, the flow diverter assembly is connected  
32 to a choke body in a branch of the christmas tree.

1 Alternatively, the flow diverter assembly is  
2 connected in series with a choke.

3  
4 According to a third aspect of the present invention  
5 there is provided a method of diverting well fluids,  
6 the method including the steps of:

7       diverting fluids from a first portion of a  
8 first flowpath to a second flowpath and diverting  
9 the fluids from the second flowpath back to a second  
10 portion of the first flowpath;

11       wherein the fluids are diverted by at least one  
12 flow diverter assembly connected to a branch of the  
13 tree.

14  
15 The flow diverter assembly is optionally located  
16 within a choke body; alternatively, the flow  
17 diverter assembly may be coupled in series with a  
18 choke. The flow diverter assembly may be located in  
19 the christmas tree branch adjacent to the choke, or  
20 it may be included within a separate extension  
21 portion of the christmas tree branch.

22  
23 Typically, the method is for recovering fluids from  
24 a well, and includes the final step of diverting  
25 fluids to an outlet of the first flowpath for  
26 recovery therefrom. Alternatively or additionally,  
27 the method is for injecting fluids into a well.

28  
29 For recovering production fluids, the first portion  
30 of the first flowpath is in communication with the  
31 production bore, and the second portion of the first  
32 flowpath is connected to a pipeline for carrying



1 away the recovered fluids (e.g. to the surface).  
2 For injecting fluids into the well, the first  
3 portion of the first flowpath is typically connected  
4 to an external fluid line, and the second portion of  
5 the first flowpath is in communication with the  
6 annulus bore. Optionally, the flow directions may  
7 be reversed.

8  
9 Preferably, the first and second portions of the  
10 first flowpath comprise two separate regions within  
11 the branch of the tree. Typically, the fluids are  
12 diverted by a flow diverter assembly comprising a  
13 conduit, the two separate regions being the bore of  
14 the conduit, and the annulus between the conduit and  
15 the branch.

16  
17 Optionally, the method includes the steps of  
18 recovering production fluids from a well and  
19 injecting at least a portion of the production  
20 fluids into a well. Optionally, at least a portion  
21 of the production fluids are returned to the same  
22 well.

23  
24 For example, the production fluids could be  
25 separated into hydrocarbons and water; the  
26 hydrocarbons being returned to the first flowpath  
27 for recovery therefrom, and the water being returned  
28 and injected into the same, or a different, well.

29  
30 Optionally, both of the steps of recovering fluids  
31 and injecting fluids include using respective flow  
32 diverter assemblies. Alternatively, only one of the

1 steps of recovering and injecting fluids includes  
2 using a flow diverter assembly.

3  
4 Optionally, the method includes the step of  
5 diverting the fluids through a processing apparatus.  
6 Typically, the processing apparatus is selected from  
7 at least one of the group consisting of:  
8 a pump; a process fluid turbine; injection apparatus  
9 for injecting gas or steam; chemical injection  
10 apparatus; a fluid riser; measurement apparatus;  
11 temperature measurement apparatus; flow rate  
12 measurement apparatus; constitution measurement  
13 apparatus; consistency measurement apparatus; gas  
14 separation apparatus; water separation apparatus;  
15 solids separation apparatus; and hydrocarbon  
16 separation apparatus.

17  
18 According to a fourth aspect of the present  
19 invention, there is provided a christmas tree having  
20 a production bore and an annulus bore and:

21 a first diverter assembly in communication with  
22 the production bore;

23 a second diverter assembly in communication  
24 with the annulus bore;

25 wherein the first and second diverter  
26 assemblies are each adapted to divert fluids from a  
27 first portion of a respective first flowpath to a  
28 respective second flowpath, and to divert fluids  
29 from the respective second flowpath back to a second  
30 portion of the respective first flowpath, the first  
31 portion of the respective first flowpath, the  
32 respective second flowpath and the second portion of

1 the respective first flowpath forming a conduit for  
2 continuous passage of fluid.

3  
4 Certain embodiments have the advantage that the  
5 first and second diverter assemblies can be  
6 connected together to allow the unwanted parts of  
7 the produced fluids (e.g. water and sand) to be  
8 directly injected back into the well, instead of  
9 being pumped away with the hydrocarbons. The  
10 unwanted materials can be extracted from the  
11 hydrocarbons substantially at the wellhead, which  
12 reduces the quantity of production fluids to be  
13 pumped away, thereby saving energy. The first and  
14 second diverter assemblies can alternatively or  
15 additionally be used to connect to other kinds of  
16 processing apparatus, such as a booster pump, filter  
17 apparatus, chemical injection apparatus, etc. to  
18 allow adding or taking away of substances and  
19 adjustment of pressure to be carried out adjacent to  
20 the wellhead. The first and second diverter  
21 assemblies enable processing to be performed on both  
22 fluids being recovered and fluids being injected.  
23 Preferred embodiments of the invention enable both  
24 recovery and injection to occur simultaneously in  
25 the same well.

26  
27 Typically, the respective second flowpaths of the  
28 first and second diverter assemblies are connectable  
29 to allow the transfer of fluids between the first  
30 and the second diverter assemblies.  
31

1 Typically, the respective second flowpaths of the  
2 first and second diverter assemblies comprise  
3 conduits connecting the first and second diverter  
4 assemblies to a processing apparatus.

5  
6 Typically, the processing apparatus is selected from  
7 at least one of the group consisting of:  
8 a pump; a process fluid turbine; injection apparatus  
9 for injecting gas or steam; chemical injection  
10 apparatus; a fluid riser; measurement apparatus;  
11 temperature measurement apparatus; flow rate  
12 measurement apparatus; constitution measurement  
13 apparatus; consistency measurement apparatus; gas  
14 separation apparatus; water separation apparatus;  
15 solids separation apparatus; and hydrocarbon  
16 separation apparatus.

17  
18 Preferably, at least one of the first and second  
19 diverter assemblies is adapted to connect to a  
20 branch of the christmas tree.

21  
22 Typically, at least a part of the first and second  
23 diverter assemblies are adapted to be inserted  
24 within a respective choke body, so that the diverter  
25 assemblies replace the choke. Alternatively the  
26 first and second diverter assemblies are connectable  
27 to a branch of the christmas tree in series with  
28 respective chokes.

29  
30 Preferably, at least one of the first and second  
31 diverter assemblies comprises a conduit.

32 Preferably, the conduit is adapted to be located

1 within a bore of the christmas tree branch.  
2 Preferably the conduit is adapted be sealed within  
3 the bore of the christmas tree branch. Preferably,  
4 the conduit divides the bore of the christmas tree  
5 branch into two separate regions, so that the first  
6 portion of the first flowpath and the second portion  
7 of the first flowpath comprise the outside and the  
8 inside of the conduit.

9  
10 Typically, at least one of the first and second  
11 diverter assemblies has a respective outer  
12 cylindrical member. Preferably, one of the first  
13 and second portions of the first flowpath comprises  
14 an annulus between the outer cylindrical member and  
15 the conduit and the other of the first and second  
16 portions of the first flowpath comprises an interior  
17 bore of the conduit.

18  
19 Typically, a tubing system adapted to both recover  
20 and inject fluids is also provided. Preferably, the  
21 tubing system is adapted to simultaneously recover  
22 and inject fluids.

23  
24 According to a fifth aspect of the present invention  
25 there is provided a method of recovering fluids  
26 from, and injecting fluids into, a well, the well  
27 having a tree including a production bore and an  
28 annulus bore, the method including the steps of:  
29 using a first diverter assembly coupled to the  
30 production bore to divert production fluids from a  
31 first portion of a first flowpath to a second  
32 flowpath and to divert at least some of the

1 production fluids from the second flowpath back to a  
2 second portion of the first flowpath for recovery  
3 therefrom via an outlet of the first flowpath; and  
4 using a second diverter assembly coupled to the  
5 annulus bore to divert injection fluids into the  
6 annulus bore.

7  
8 Preferably, at least a part of the first flowpath  
9 comprises a branch of the tree.

10  
11 Typically, at least one of the first and second flow  
12 diverter assemblies is coupled to a branch of the  
13 christmas tree. Typically, at least a part of at  
14 least one of the first and second flow diverter  
15 assemblies is located within a choke body.  
16 Optionally, the method also includes the step of  
17 passing at least some of the fluids through a choke.

18  
19 Preferably, a processing apparatus is coupled to the  
20 second flowpath.

21  
22 Typically, the processing apparatus is selected from  
23 at least one of the group consisting of:

24 a pump; a process fluid turbine; injection  
25 apparatus for injecting gas or steam; chemical  
26 injection apparatus; a fluid riser; measurement  
27 apparatus; temperature measurement apparatus; flow  
28 rate measurement apparatus; constitution measurement  
29 apparatus; consistency measurement apparatus; gas  
30 separation apparatus; water separation apparatus;  
31 solids separation apparatus; and hydrocarbon  
32 separation apparatus.

1  
2 Preferably, the processing apparatus separates  
3 hydrocarbons from the rest of the produced fluids.  
4 Typically, the non-hydrocarbon components of the  
5 produced fluids are diverted to the second diverter  
6 assembly to provide at least one component of the  
7 injection fluids.

8  
9 Optionally, at least one component of the injection  
10 fluids is provided by an external fluid line which  
11 is not connected to the production bore or to the  
12 first diverter assembly.

13  
14 Optionally, the second diverter assembly diverts at  
15 least some of the injection fluids (typically fluids  
16 provided from an external fluid line) from a first  
17 portion of a first flowpath to a second flowpath and  
18 diverts the fluids from the second flowpath back to  
19 a second portion of the first flowpath for injection  
20 into the annulus bore of the well.

21  
22 Typically, the steps of recovering fluids from the  
23 well and injecting fluids into the well are carried  
24 out simultaneously.

25  
26 According to a sixth aspect of the invention there  
27 is provided a flow diverter assembly comprising a  
28 conduit adapted to be inserted within a christmas  
29 tree branch bore, such that the bore of the conduit  
30 defines a first flow region and the annulus between  
31 the conduit and the christmas tree branch bore  
32 defines a second flow region.

1  
2 An embodiment of the invention will now be  
3 described, by way of example only, and with  
4 reference to the following drawings, in which:-

5  
6 Fig 1 shows a cross-sectional view of a tree having  
7 a first diverter assembly coupled to a first branch  
8 of the tree and a second diverter assembly coupled  
9 to a second branch of the tree; and

10  
11 Fig 2 shows a schematic view of the Fig 1 assembly  
12 used in conjunction with a first downhole tubing  
13 system;

14  
15 Fig 3 shows an alternative embodiment of a downhole  
16 tubing system which could be used with the Fig 1  
17 assembly;

18  
19 Figs 4 and 5 show alternative embodiments of the  
20 invention, each having a flow diverter assembly  
21 coupled to a modified christmas tree branch between  
22 a choke and a production wing valve;

23  
24 Figs 6 and 7 show further alternative embodiments,  
25 each having a flow diverter assembly coupled to a  
26 modified christmas tree branch below a choke; and

27  
28 Fig 8 shows a first flow diverter assembly used to  
29 divert fluids from a first well and connected to an  
30 input header; and a second flow diverter assembly  
31 used to divert fluids from a second well and  
32 connected to an output header.



1  
2 Referring to the drawings, Fig 1 shows a  
3 conventional tree 601 having a production bore 602  
4 and an annulus bore 603.

5  
6 The tree has a production wing 620 and associated  
7 production wing valve 610. The production wing 620  
8 terminates in a production choke body 630. The  
9 production choke body 630 has an interior bore 607  
10 extending therethrough in a direction perpendicular  
11 to the production wing 620. The bore 607 of the  
12 production choke body is in communication with the  
13 production wing 620 so that the choke body 630 forms  
14 an extension portion of the production wing 620.  
15 The opening at the lower end of the bore 607  
16 comprises an outlet 612. In prior art trees, a  
17 choke is usually installed in the production choke  
18 body 630, but in the tree 601 of the present  
19 invention, the choke itself has been removed.

20  
21 Similarly, the tree 601 also has an annulus wing  
22 621, an annulus wing valve 611, an annulus choke  
23 body 631 and an interior bore 609 of the annulus  
24 choke body 631 terminating in an inlet 613 at its  
25 lower end. There is no choke inside the annulus  
26 choke body 631.

27  
28 Attached to the production choke body 630 of the  
29 production wing 620 is a first flow diverter  
30 assembly 604 in the form of a production insert.  
31 The production insert 604 comprises a substantially  
32 cylindrical housing 640, a conduit 642, an inlet 646

1 and an outlet 644. The housing 640 has a reduced  
2 diameter portion 641 at an upper end and an  
3 increased diameter portion 643 at a lower end.

4  
5 The conduit 642 has an inner bore 649, and forms an  
6 extension of the reduced diameter portion 641. The  
7 conduit 642 is longer than the housing 640 so that  
8 it extends beyond the end of the housing 640.

9  
10 The space between the outer surface of the conduit  
11 642 and the inner surface of the housing 640 forms  
12 an axial passage 647, which ends where the conduit  
13 642 extends out from the housing 640. A connecting  
14 lateral passage is provided adjacent to the join of  
15 the conduit 642 and the housing 640; the lateral  
16 passage is in communication with the axial passage  
17 647 of the housing 640 and terminates in the outlet  
18 644.

19  
20 The lower end of the housing 640 is attached to the  
21 upper end of the production choke body 630 at a  
22 clamp 648. The conduit 642 is sealingly attached  
23 inside the inner bore 607 of the choke body 630 at  
24 an annular seal 645.

25  
26 Attached to the annular choke body 631 is a second  
27 flow diverter assembly 605. The second diverter  
28 assembly 605 is of the same form as the first  
29 diverter assembly 604, with the dimensions suitably  
30 adjusted to fit the smaller annulus choke body 631.  
31 The components of the second flow diverter assembly  
32 605 are the same as those of the first flow diverter

1 assembly 604, including a housing 680 comprising a  
2 reduced diameter portion 681 and an enlarged  
3 diameter portion 683; a conduit 682 extending from  
4 the reduced diameter portion 681 and having a bore  
5 689; an outlet 686; an inlet 684; and an axial  
6 passage 687 formed between the enlarged diameter  
7 portion 683 of the housing 680 and the conduit 682.  
8 A connecting lateral passage is provided adjacent to  
9 the join of the conduit 682 and the housing 680; the  
10 lateral passage is in communication with the axial  
11 passage 687 of the housing 680 and terminates in the  
12 inlet 684. The housing 680 is clamped by a clamp  
13 688 on the annulus choke body 631, and the conduit  
14 682 is sealed to the inside of the annulus choke  
15 body 631 at seal 685.

16  
17 A conduit 690 connects the outlet 644 of the first  
18 diverter assembly 604 to a processing apparatus 700.  
19 In this embodiment, the processing apparatus 700  
20 comprises bulk water separation equipment, which is  
21 adapted to separate water from hydrocarbons. A  
22 further conduit 692 connects the inlet 646 of the  
23 first diverter assembly 604 to the processing  
24 apparatus 700. Likewise, conduits 694, 696 connect  
25 the outlet 686 and the inlet 684 respectively of the  
26 second flow diverter assembly 605 to the processing  
27 apparatus 700. The processing apparatus 700 has  
28 pumps 820 fitted into the conduits between the  
29 separation vessel and the first and second flow  
30 diverter assemblies 604, 605.

31

1 The production bore 602 and the annulus bore 603  
2 extend down into the well from the tree 601, where  
3 they are connected to a tubing system 800a, shown in  
4 Fig 2.

5  
6 The tubing system 800a is adapted to allow the  
7 simultaneous injection of a first fluid into an  
8 injection zone 805 and production of a second fluid  
9 from a production zone 804. The tubing system 800a  
10 comprises an inner tubing 810 which is located  
11 inside an outer tubing 812. The production bore 602  
12 is the inner bore of the inner tubing 810. The  
13 inner tubing 810 has perforations 814 in the region  
14 of the production zone 804. The outer tubing has  
15 perforations 816 in the region of the injection zone  
16 805. A cylindrical plug 801 is provided in the  
17 annulus bore 603 which lies between the outer tubing  
18 812 and the inner tubing 810. The plug 801  
19 separates the part of the annulus bore 803 in the  
20 region of the injection zone 805 from the rest of  
21 the annulus bore 803.

22  
23 In use, the produced fluids (typically a mixture of  
24 hydrocarbons and water) enter the inner tubing 810  
25 through the perforations 814 and pass into the  
26 production bore 602. The produced fluids then pass  
27 through the production wing 620, the axial passage  
28 647, the outlet 644, and the conduit 690 into the  
29 processing apparatus 700. The processing apparatus  
30 700 separates the hydrocarbons from the water (and  
31 optionally other elements such as sand), e.g. using  
32 centrifugal separation.

1

2 The separated hydrocarbons flow into the conduit  
3 692, from where they return to the first flow  
4 diverter assembly 604 via the inlet 646. The  
5 hydrocarbons then flow down through the conduit 642  
6 and exit the choke body 630 at outlet 612, e.g. for  
7 removal to the surface.

8

9 The water separated from the hydrocarbons by the  
10 processing apparatus 700 is diverted through the  
11 conduit 696, the axial passage 687, and the annulus  
12 wing 611 into the annulus bore 603. When the water  
13 reaches the injection zone 805, it passes through  
14 the perforations 816 in the outer tubing 812 into  
15 the injection zone 805.

16

17 If desired, extra fluids can be injected into the  
18 well in addition to the separated water. These  
19 extra fluids flow into the second diverter assembly  
20 631 via the inlet 613, flow directly through the  
21 conduit 682, the conduit 694 and into the processing  
22 apparatus 700. These extra fluids are then directed  
23 back through the conduit 696 and into the annulus  
24 bore 603 as explained above for the path of the  
25 separated water.

26

27 Fig 3 shows an alternative form of tubing system  
28 800b including an inner tubing 820, an outer tubing  
29 822 and an annular seal 821, for use in situations  
30 where a production zone 824 is located above an  
31 injection zone 825. The inner tubing 820 has  
32 perforations 836 in the region of the production

1 zone 824 and the outer tubing 822 has perforations  
2 834 in the region of the injection zone 825.

3  
4 The outer tubing 822, which generally extends round  
5 the circumference of the inner tubing 820, is split  
6 into a plurality of axial tubes in the region of the  
7 production zone 824. This allows fluids from the  
8 production zone 824 to pass between the axial tubes  
9 and through the perforations 836 in the inner tubing  
10 820 into the production bore 602. From the  
11 production bore 602 the fluids pass upwards into the  
12 tree as described above. The returned injection  
13 fluids in the annulus bore 603 pass through the  
14 perforations 834 in the outer tubing 822 into the  
15 injection zone 825.

16  
17 Figs 4 to 7 illustrate alternative embodiments where  
18 the flow diverter assembly is not inserted within a  
19 choke body. These embodiments therefore allow a  
20 choke to be used in addition to the flow diverter  
21 assembly.

22  
23 Fig 4 shows a tree 900 having a production bore 902,  
24 a production wing branch 920, a production wing  
25 valve 910, an outlet 912 and a production choke 930.  
26 The production choke 930 is a full choke, fitted as  
27 standard in many christmas trees, in contrast with  
28 the production choke body 630 of the Fig 1  
29 embodiment, from which the actual choke has been  
30 removed. In Fig 4, the production choke 930 is  
31 shown in a fully open position.

32

1 A flow diverter assembly 904 in the form of a  
2 production insert is located in the production wing  
3 branch 920 between the production wing valve 910 and  
4 the production choke 930. The flow diverter  
5 assembly 904 is the same as the flow diverter  
6 assembly 604 of the Fig 1 embodiment, and like parts  
7 are designated here by like numbers, prefixed by  
8 "9". Like the Fig 1 embodiment, the Fig 4 housing  
9 940 is attached to the production wing branch 920 at  
10 a clamp 948.

11  
12 The lower end of the conduit 942 is sealed inside  
13 the production wing branch 920 at a seal 945. The  
14 production wing branch 920 includes a secondary  
15 branch 921 which connects the part of the production  
16 wing branch 920 adjacent to the diverter assembly  
17 904 with the part of the production wing branch 920  
18 adjacent to the production choke 930. A valve 922  
19 is located in the production wing branch 920 between  
20 the diverter assembly 904 and the production choke  
21 930.

22  
23 The combination of the valve 922 and the seal 945  
24 prevents production fluids from flowing directly  
25 from the production bore 902 to the outlet 912.  
26 Instead, the production fluids are diverted into the  
27 axial annular passage 947 between the conduit 942  
28 and the housing 940. The fluids then exit the  
29 outlet 944 into a processing apparatus (examples of  
30 which are described above), then re-enter the  
31 diverter assembly via the inlet 946, from where they

1 pass through the conduit 942, through the secondary  
2 branch 921, the choke 930 and the outlet 912.

3

4 Fig 5 shows an alternative embodiment of the Fig 4  
5 design, and like parts are denoted by like numbers  
6 having a prime. In this embodiment, the valve 922  
7 is not needed because the secondary branch 921'  
8 continues directly to the production choke 930',  
9 instead of rejoining the production wing branch  
10 920'. Again, the diverter assembly 904' is sealed  
11 in the production wing branch 920', which prevents  
12 fluids from flowing directly along the production  
13 wing branch 920', the fluids instead being diverted  
14 through the diverter assembly 904'.

15

16 Fig 6 shows a further embodiment, in which a  
17 diverter assembly 1004 is located in an extension  
18 1021 of a production wing branch 1020 beneath a  
19 choke 1030. The diverter assembly 1004 is the same  
20 as the diverter assemblies of Figs 4 and 5; it is  
21 merely rotated at 90 degrees with respect to the  
22 production wing branch 1020.

23

24 The diverter assembly 1004 is sealed within the  
25 branch extension 1021 at a seal 1045. A valve 1022  
26 is located in the branch extension 1021 below the  
27 diverter assembly 1004.

28

29 The branch extension 1021 comprises a primary  
30 passage 1060 and a secondary passage 1061, which  
31 departs from the primary passage 1060 on one side of



1 the valve 1022 and rejoins the primary passage 1060  
2 on the other side of the valve 1022.

3  
4 Production fluids pass through the choke 1030 and  
5 are diverted by the valve 1022 and the seal 1045  
6 into the axial annular passage 1047 of the diverter  
7 assembly 1004 to an outlet 1044. They are then  
8 typically processed by a processing apparatus, as  
9 described above, and then they are returned to the  
10 bore 1049 of the diverter assembly 1004, from where  
11 they pass through the secondary passage 1061, back  
12 into the primary passage 1060 and out of the outlet  
13 1012.

14  
15 Fig 7 shows a modified version of the Fig 6  
16 apparatus, in which like parts are designated by the  
17 same reference number with a prime. In this  
18 embodiment, the secondary passage 1061' does not  
19 rejoin the primary passage 1060'; instead the  
20 secondary passage 1061' leads directly to the outlet  
21 1012'. This embodiment works in the same way as the  
22 Fig 6 embodiment.

23  
24 The embodiments of Figs 6 and 7 could be modified  
25 for use with a conventional christmas tree by  
26 incorporating the diverter assembly 1004, 1004' into  
27 further pipework attached to the tree, instead of  
28 within an extension branch of the tree.

29  
30 Fig 8 illustrates an alternative method of using the  
31 flow diverter assemblies in the recovery of fluids  
32 from multiple wells. The flow diverter assemblies

1 can be any of the ones shown in the previously  
2 illustrated embodiment, and are not shown in detail  
3 in this Figure; for this example, the flow diverter  
4 assemblies are the production flow diverter  
5 assemblies of Fig 1.

6  
7 A first diverter assembly 704 is connected to a  
8 branch of a first production well A. The diverter  
9 assembly 704 comprises a conduit (not shown) sealed  
10 within the bore of a choke body to provide a first  
11 flow region inside the bore of the conduit and a  
12 second flow region in the annulus between the  
13 conduit and the bore of the choke body. It is  
14 emphasised that the flow diverter assembly 704 is  
15 the same as the flow diverter assembly 604 of Fig 1;  
16 however it is being used in a different way, so some  
17 outlets of Fig 1 correspond to inlets of Fig 8 and  
18 vice versa.

19  
20 The bore of the conduit has an inlet 712 and an  
21 outlet 746 (inlet 712 corresponds to outlet 612 of  
22 Fig 1 and outlet 746 corresponds to inlet 646 of Fig  
23 1). The inlet 712 is in communication with an input  
24 header 701. The input header 701 may contain  
25 produced fluids from several other production wells  
26 (not shown).

27  
28 The annular passage between the conduit and the  
29 choke body is in communication with the production  
30 wing branch of the tree of the first well A, and  
31 with the outlet 744 (which corresponds to the outlet  
32 644 in Fig 1).

1  
2 Likewise, a second diverter assembly 714 is  
3 connected to a branch of a second production well B.  
4 The second diverter assembly 714 is the same as the  
5 first diverter assembly 704, and is located in a  
6 production wing branch in the same way. The bore of  
7 the conduit of the second diverter assembly has an  
8 inlet 756 (corresponding to the inlet 646 in Fig 1)  
9 and an outlet 722 (corresponding to the outlet 612  
10 of Fig 1). The outlet 722 is connected to an output  
11 header 703. The output header 703 is a conduit for  
12 conveying the produced fluids to the surface, for  
13 example, and may also be fed from several other  
14 wells (not shown).

15  
16 The annular passage between the conduit and the  
17 inside of the choke body connects the production  
18 wing branch to an outlet 754 (which corresponds to  
19 the outlet 644 of Fig 1).

20  
21 The outlets 746, 744 and 754 are all connected via  
22 tubing to the inlet of a pump 750. Pump 750 then  
23 passes all of these fluids into the inlet 756 of the  
24 second diverter assembly 714. Optionally, further  
25 fluids from other wells (not shown) are also pumped  
26 by pump 750 and passed into the inlet 756.

27  
28 In use, the second diverter assembly 714 functions  
29 in the same way as the diverter assembly 604 of the  
30 Fig 1 embodiment. Fluids from the production bore  
31 of the second well B are diverted by the conduit of  
32 the second flow diverter assembly 714 into the

1 annular passage between the conduit and the inside  
2 of the choke body, from where they exit through  
3 outlet 754, pass through the pump 750 and are then  
4 returned to the bore of the conduit through the  
5 inlet 756. The returned fluids pass straight  
6 through the bore of the conduit and into the outlet  
7 header 703, from where they are recovered.

8  
9 The first diverter assembly 704 functions  
10 differently because the produced fluids from the  
11 first well 702 are not returned to the first flow  
12 diverter assembly 704 once they leave the outlet 744  
13 of the annulus. Instead, both of the flow regions  
14 inside and outside of the conduit have fluid flowing  
15 in the same direction. Inside the conduit (the  
16 first flow region), fluids flow upwards from the  
17 input header 701 straight through the conduit to the  
18 outlet 746. Outside of the conduit (the second flow  
19 region), fluids flow upwards from the production  
20 bore of the first well 702 to the outlet 744.

21  
22 Both streams of upwardly flowing fluids combine with  
23 fluids from the outlet 754 of the second diverter  
24 assembly 714, from where they enter the pump 750,  
25 pass through the second diverter assembly into the  
26 outlet header 703, as described above.

27  
28 Modifications and improvements can be incorporated  
29 without departing from the scope of the invention.  
30 For example, the tree 1 is a conventional tree but  
31 the invention can also be used with horizontal  
32 trees.

1

2 One or both of the flow diverter assemblies of the  
3 Fig 1 embodiment could be located within the  
4 production bore and/or the annulus bore, instead of  
5 within the production and annular choke bodies.

6

7 The processing apparatus 700 could be one or more of  
8 a wide variety of equipment. For example, the  
9 processing apparatus 700 could comprise a pump or  
10 process fluid turbine, for boosting the pressure of  
11 the fluid. Alternatively, or additionally, the  
12 processing apparatus could inject gas or steam into  
13 the well fluids. The injection of gas could be  
14 advantageous, as it would give the fluids "lift",  
15 making them easier to pump. The addition of steam  
16 has the effect of adding energy to the fluids.

17 The processing apparatus 700 could also enable  
18 chemicals to be added to the well fluids, e.g.  
19 viscosity moderators, which thin out the produced  
20 fluids, making them easier to pump, or pipe skin  
21 friction moderators, which minimise the friction  
22 between the fluids and the pipes. The chemicals/  
23 injected materials could be added via one or more  
24 additional input conduits. The processing apparatus  
25 700 could also comprise a fluid riser, which could  
26 provide an alternative route to the surface for the  
27 produced fluids. The processing equipment could  
28 alternatively or additionally include measurement  
29 apparatus, e.g. for measuring the temperature/flow  
30 rate/constitution/ consistency, etc. The separation  
31 equipment may be adapted to separated gas, water,  
32 sand/debris and/or hydrocarbons.

1

2     The pumps 820 are optional.

3

4     The above described flow paths could be completely  
5     reversed or redirected for other process  
6     requirements.

7

8     The tubing system 800a, 800b could be any system  
9     which allows both production and injection; the  
10    system is not limited to the examples given above.  
11    Optionally, the tubing system could comprise two  
12    conduits which are side by side, instead of one  
13    inside the other, one of the conduits providing the  
14    production bore and the second providing the annulus  
15    bore.

16

17

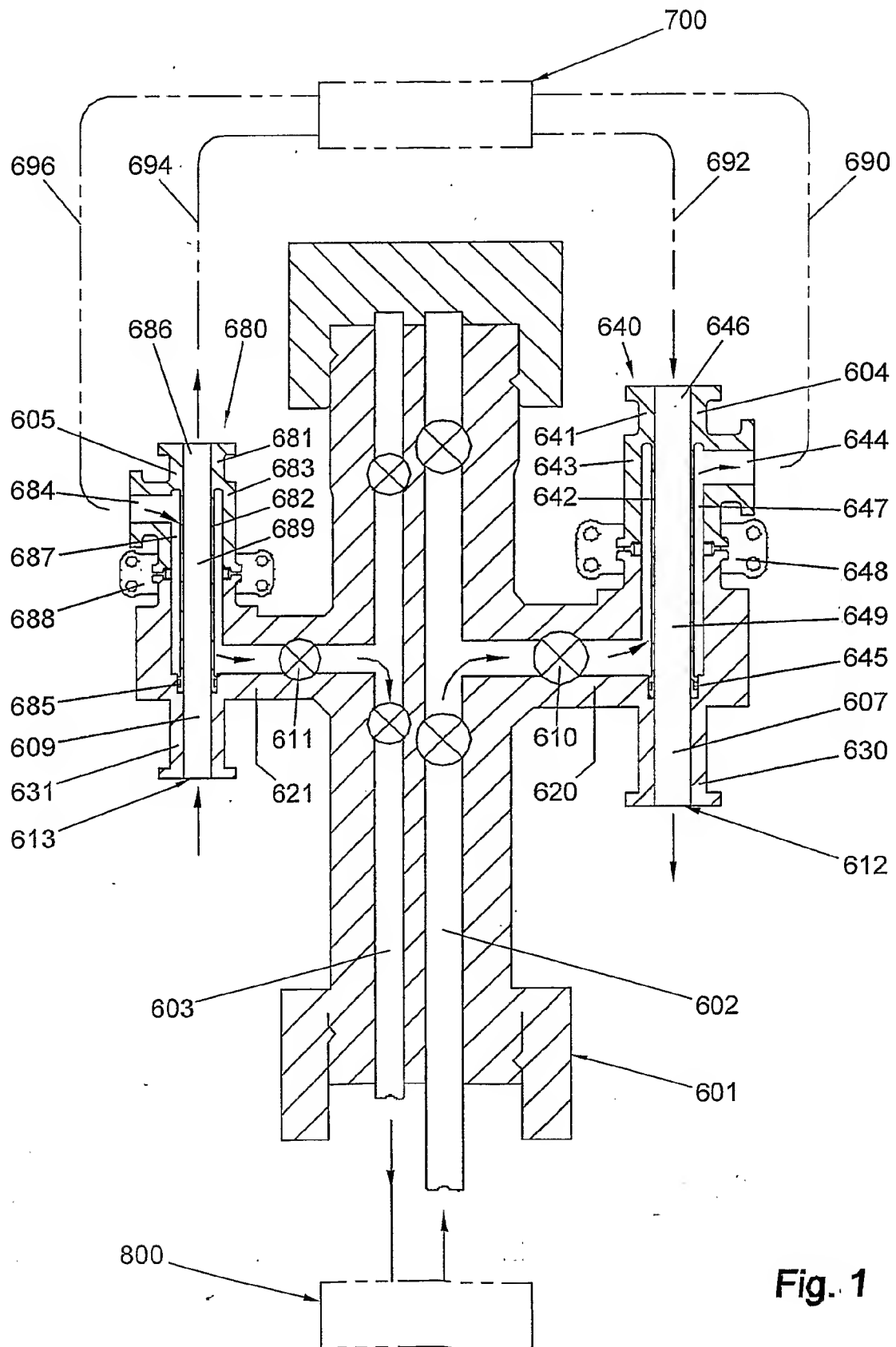
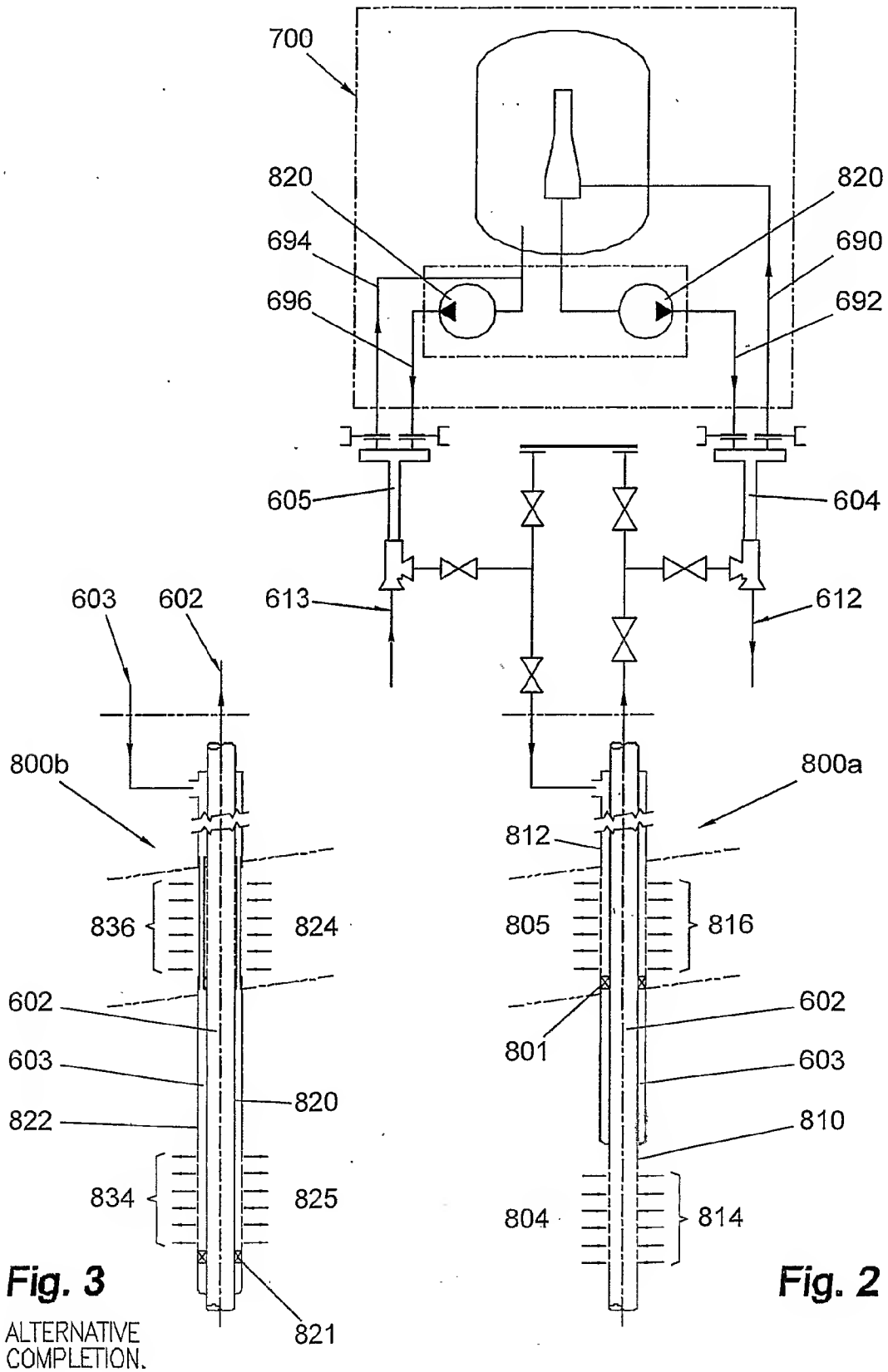


Fig. 1



**Fig. 3**  
ALTERNATIVE  
COMPLETION.

**Fig. 2**



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SUBSEA TREE, MARS  
HORIZONTAL LINE INSERT  
c/w ADDITIONAL VALVE.

Fig 4

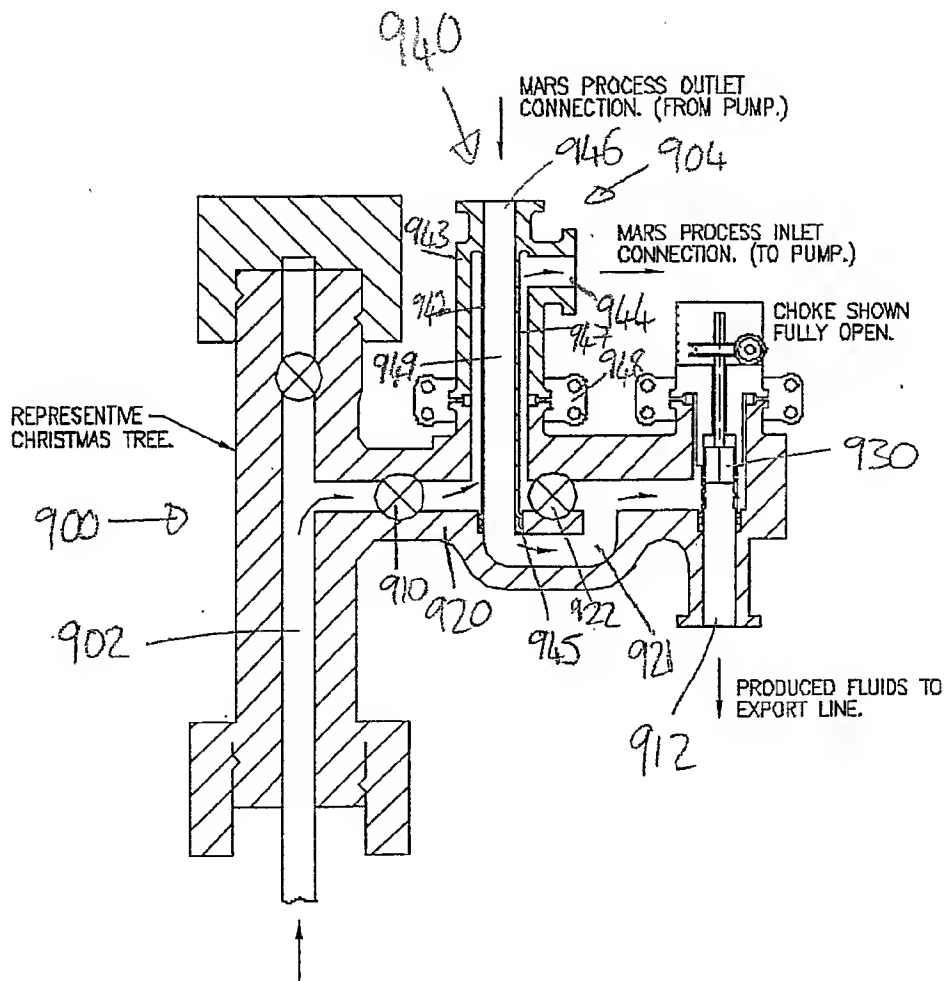
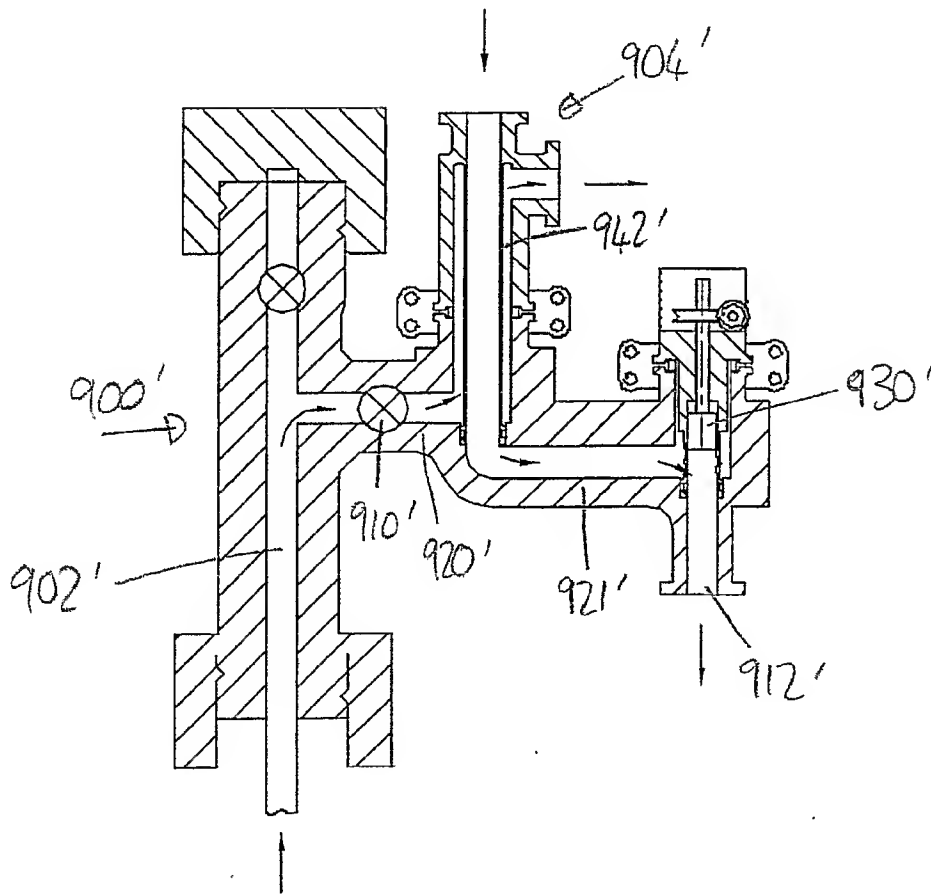


Fig 5

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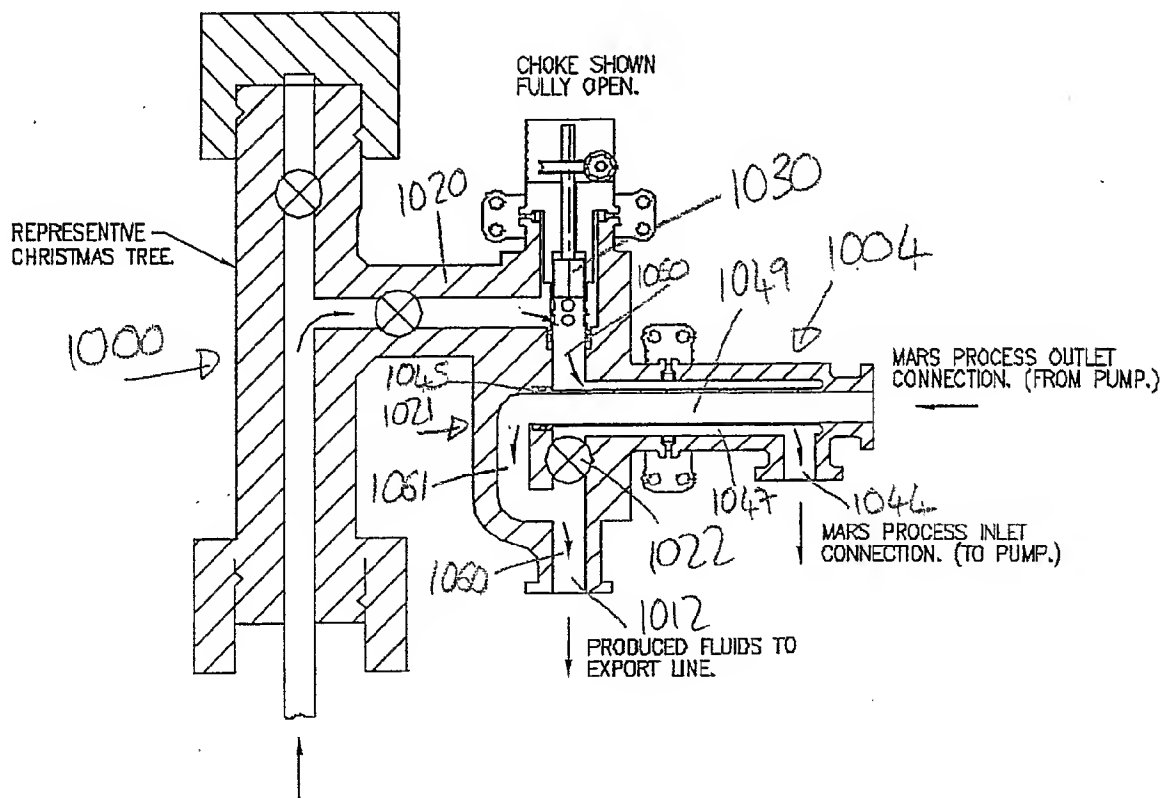
SUBSEA TREE, MARS  
HORIZONTAL LINE INSERT.



S/7

SUBSEA TREE, MARS  
VERTICAL LINE INSERT  
c/w ADDITIONAL VALVE.

Fig 6



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SUBSEA TREE, MARS  
VERTICAL LINE INSERT.

Fig 7

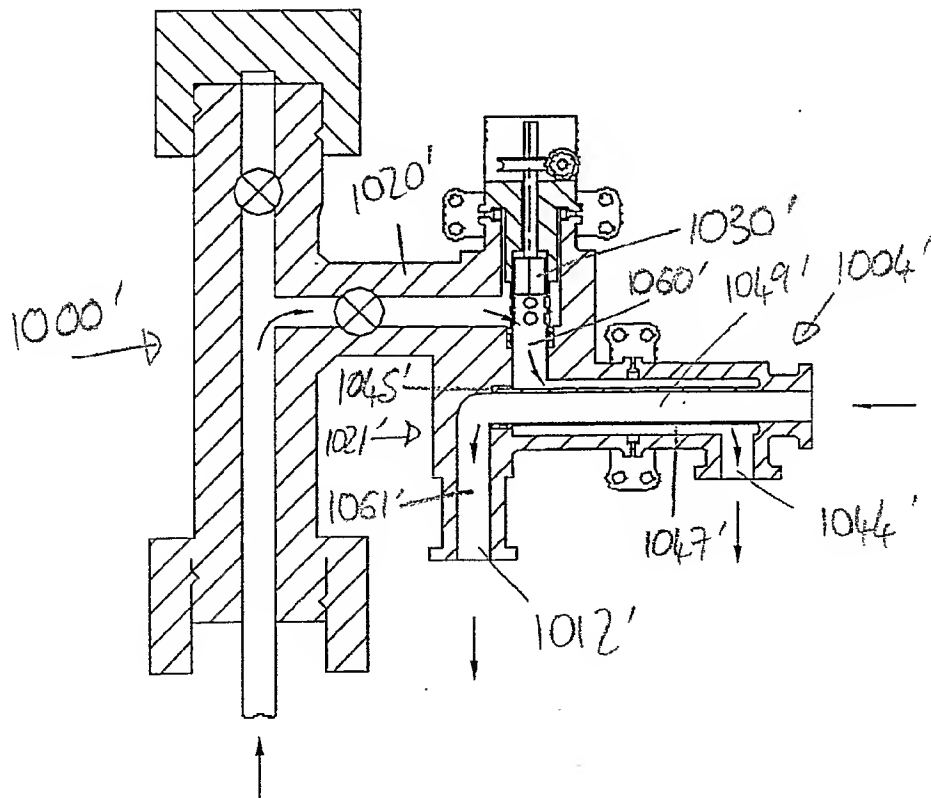


Fig 8

